

# A Walk Through the MSA Software Spectrum Analyzer Mode

12/12/09

This document is intended to familiarize you with the basic features of the MSA and its software, operating as a Spectrum Analyzer, without the need for you to have the MSA hardware. All that is necessary is that you have installed the software per Scotty's instructions.

## Hardware Configuration

1. Double-click the icon for the MSA software.
2. The software will run and open the Configuration Manager. (If you have already run the software once, you need to open menu Setup→Hardware Config Manager.)
3. On the right side the final filter box will show a default filter. Add another by typing "10.6" in the Freq box, then "30" in the BW box, and clicking "Add". This adds a filter with center frequency 10.6 MHz and 30 kHz bandwidth. Normally, you would enter data here to match the hardware filters you actually have available.
4. Click "Save Configuration". The software will quit.

## Running in Spectrum Analyzer Mode

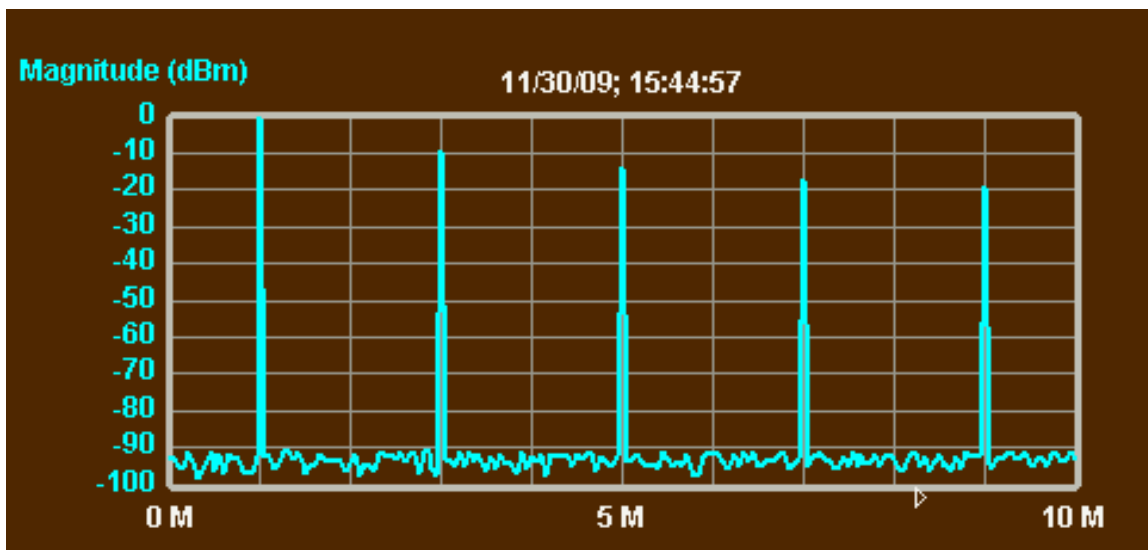
1. Double-click the icon for The MSA software. **Warning: You may resize the MSA graph window, but you must be sure the scan is halted (click Halt) before doing so. Resizing while a scan is in progress has a 50-50 chance of crashing the program, due to a Liberty Basic bug.**
2. The software will open in Spectrum Analyzer (SA) mode, unless you previously changed the preferred mode. If need be, select menu Mode→SA to get to SA mode.
3. The graph will update as though it is actually operating the hardware, but the data it generates is uninteresting.
4. Click Halt. The MSA will halt and a triangular marker is placed on the frequency axis at the last completed step, and information about the graph at that step is displayed below the graph area. Click Continue to resume scanning, or click One Step to scan the next step and then halt.
5. Open the Sweep Parameters window by double-clicking below the frequency axis, or by using menu Options→Sweep. This window provides many options for controlling the sweep.

6. In the Data Mode Box, select item 5 (1 MHz Square Wave). This will generate data to view.

7. At the far right, click the Start/Stop box and enter a start frequency of 0 MHz and a stop frequency of 10 MHz.

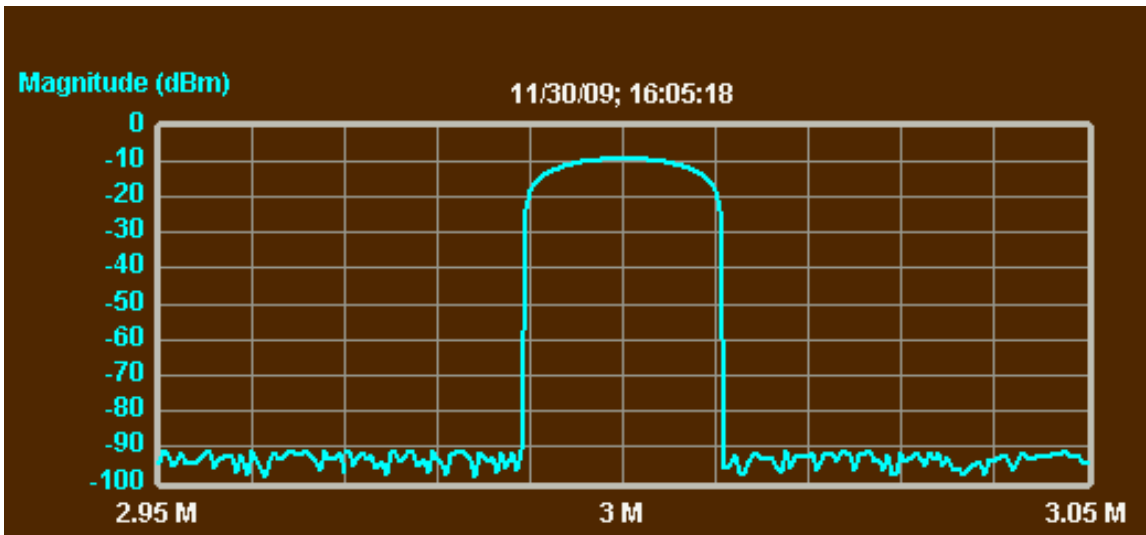
8. In the steps/sweep box, enter 200.

9. Click OK. The window will close. If you halted scanning above, click Restart. Then click Halt At End. At the end of the current sweep, the MSA will halt. A graph similar to the following will be produced:



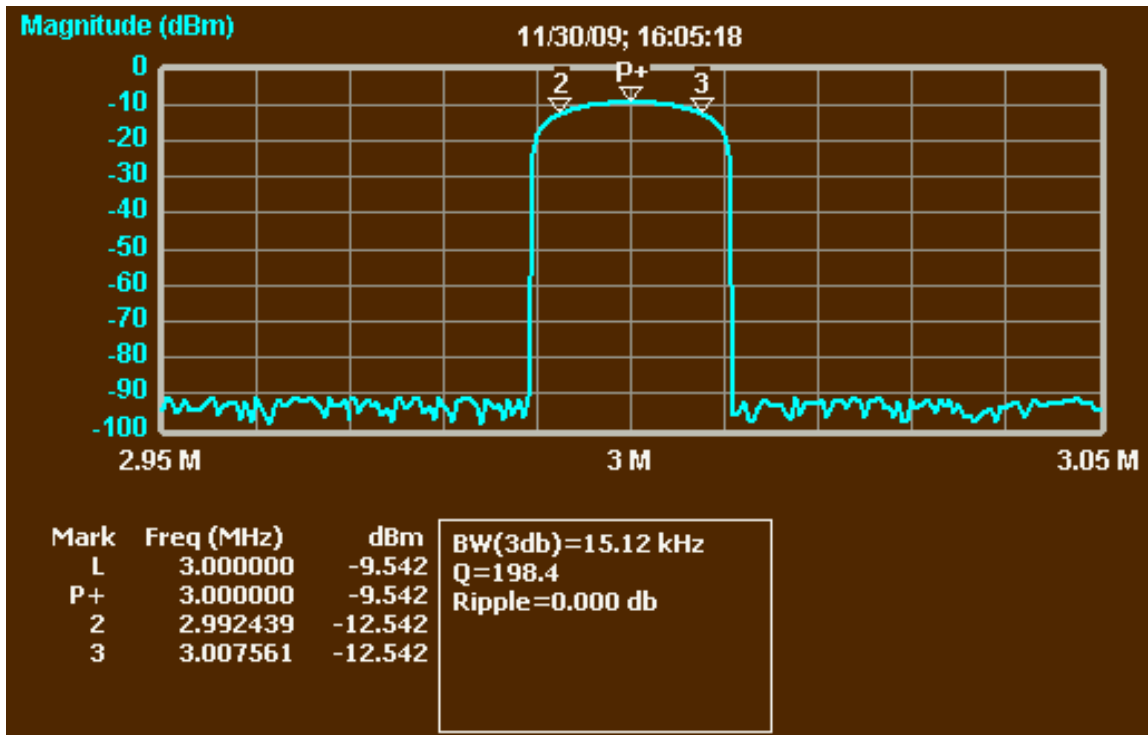
Your axis may be on the right side. If you want to change it, use menu Setup→Primary Axis. The graph shows the spectrum of an ideal 1 MHz square wave. The fundamental is at 0 dBm; there are no odd harmonics, and the odd harmonics decline in accordance with the 1/N rule. The bottom of the graph shows artificial noise.

10. Open the Sweep Parameters window again and change the frequency range. First click the Center/Span box. Then enter a center frequency of 3 MHz and a span of 0.1 MHz. Close the window and click Restart. A graph similar to the following will be produced:



This graph shows the harmonic at 3 MHz. Its width is approximately the bandwidth of the final IF filter, and its shape matches the profile of that filter. Here the profile is artificial, of course.

11. Double-click on the peak, and the L marker will be placed. The peak value will be shown below the graph in the marker info area. It will be -9.542 dBm, which represents a voltage level 1/3 that of the fundamental, whose peak is at 0 dBm.
12. You may select any other marker in the marker box at the lower left of the graph window. When you double-click on the graph, the selected marker will be placed. The marker will be placed on the trace at the frequency you clicked, except that the P+ and P- markers will move to the frequency with the maximum and minimum graph values, respectively. Delete will clear the currently selected marker. Clicking the + or - buttons will increment or decrement the marker to the next or previous step. Entering a frequency in the frequency box, and clicking Enter, will place the marker at that frequency. (Except you can't move the P+ and P- markers).
13. Select one of the numbered markers in the marker box, and double click somewhere in the noise on the graph. Click Continue or Restart if necessary to resume scanning. The marker position will update at the end of each scan.
14. Click Clear Markers to clear the all markers. Then select menu Functions→Filter Analysis. A window will open with several options; just click OK. Markers will be added to the peak and -3 dB points, as though the peak represented the response of a filter:



Note that the 3-dB bandwidth is displayed in the box. This should be approximately the bandwidth of the currently selected final IF filter. A narrow signal peak in Spectrum Analyzer mode will show some response for any tuning frequency closer than half the final IF bandwidth of center, and even somewhat outside that range. The resulting image is thus similar to what you would get using the Spectrum Analyzer plus Tracking Generator to scan an external filter.

15. Open the Sweep Parameters Window. On the left side is a list of final IF filters. Choose a different one and close the window. Click Restart. If you chose a wider filter, the displayed peak will be wider, and the noise level will rise. If you chose a narrower filter, the opposite will happen.

16. Open menu Functions→Filter Analysis and uncheck the box to turn off Filter Analysis. Click OK. The markers will remain, but can be cleared by clicking Clear Markers.

17. Open the Sweep Parameters window and change the frequency range. Click the Start/Stop box and set the start frequency to 0.1 MHz and the stop frequency to 10.1 MHz. In the steps/sweep box, enter 50. Close the window and click Restart.

18. The graph will now consist entirely of noise, and no peaks are shown. The warning message tells you exactly what is happening: The MSA makes measurements in discrete steps, and it is possible for a signal to lie entirely between two steps. At each step, the MSA will detect signals for a certain width around the step frequency, that width equaling the final IF frequency. In this case, all the peaks fall between the steps.

19. Open the Sweep Parameters window and change the start frequency to 0 and the stop frequency to 10 MHz. Close the window and, if necessary, click Restart. You will once again see the peaks representing the fundamental and harmonics.

### **Adding Wait Time**

1. If you did not get to this step by following all of the above steps, open the Sweep Parameters window and set the start frequency to 0, the stop frequency to 10 MHz and the number of steps/sweep to 50. Also select item number 5 in the Data Mode box. Close the window.

2. Open the Sweep Parameters window. In the Wait Time box, enter 50. Close the window and resume scanning. The scan will now be slower, as the MSA waits 50 ms at each step to allow the data to settle. Of course, this has no effect on the simulated data, but when using a strong video filter it is necessary to add wait time to allow the filtered data to settle to its final value. Failure to do so will distort the graph; for example, it can cause a peak to shift to the right.

3. If the wait time is 15 ms or greater, the software will actually go into a brief “sleep” mode for approximately the specified time. This makes more time available for any other software you may be running. It can also allow the processor to enter a low-power-consumption mode which can extend laptop battery life.

### **Changing Sweep Direction**

1. If you did not get to this step by following all of the above steps, open the Sweep Parameters window and set the start frequency to 0, the stop frequency to 10 MHz and the number of steps/sweep to 50. Also select item number 5 in the Data Mode box. Close the window.

2. Open the Sweep Parameters window. Be sure the wait time is set to zero. In the Sweep group box at the right side, click “Alternate” to cause the sweep direction to alternate between left-right and right-left. Close the window.

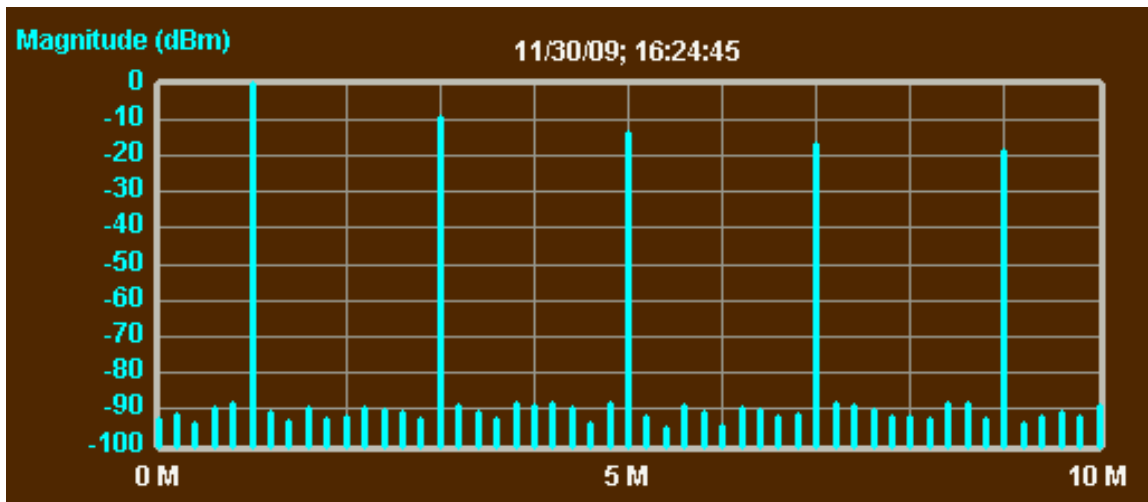
3. Resume scanning with Continue or Restart. The sweep will proceed back and forth. This is useful for analyzing circuits with hysteresis. It is also a handy way to check whether your wait time is sufficient for your selected video filter. By alternating scan direction with a signal peak displayed, any shift in the peak caused by inadequate wait time will be reversed when the sweep reverses, and will become obvious.

4. Open the Sweep Parameters window. Select sweep direction “L-R” for normal sweeping. Close the window.

### **Changing the Graph Appearance**

1. If you did not get to this step by following all of the above steps, open the Sweep Parameters window and set the start frequency to 0, the stop frequency to 10 MHz and the number of steps/sweep to 50. Also select item number 5 in the Data Mode box. Close the window.

2. Double-click on the Y-axis numeric labels, to open the Y-axis window. This presents you with several options to control the appearance of the graph trace. Select a width of 3 and whatever color you like. (The graphs shown here used a width of 2.) Change the number of vertical divisions if you like. Under Trace Style, select Histo Erase. Close the window. The graph will redraw and be similar to the following:



The histogram is a nice way to graph harmonics. The number of steps could even be reduced to eliminate the in-between noise. The fact that the histogram does not “connect the dots” is also a good reminder that we don’t really know what lies between the scan points, unless the step size is small enough to prevent a signal from squeezing between the scan points.

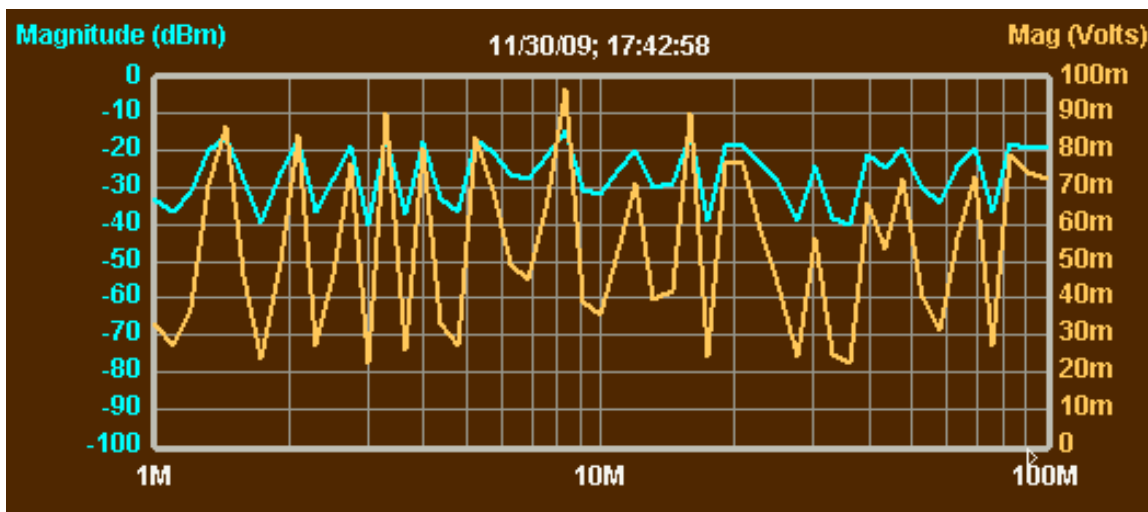
3. Double-click on the Y-axis numeric labels to open the Y-axis window. In the trace style box, select Histo Erase. Close the window. If necessary, click Restart to continue scanning. The histogram will be drawn as before, but for each scan the old histograms will not be erased. This will have no effect on the peaks, which have a fixed level, but for the noise it will cause the histogram bars to match the highest level of any scan, effectively displaying maximum noise. A similar thing can be done with the Normal trace by selecting Norm Stick.

4. Open the Y-axis window again and select Trace Style Norm Erase. Select 2 for the Trace Width. Close the window.

5. Open the Sweep Parameters window. Enter a start frequency of 1 MHz and a stop frequency of 100 MHz. Select Log Sweep. In the Data Mode box, select item number 3 (Graph Noisy Sine). Close the window and, if necessary, click Restart. The graph will show an erratic sine wave that is artificially generated

at all sweep points, and therefore can never be “stepped over”. The frequency axis will have a log scale. The benefit of a log scale is that more of the steps of the scan are devoted to lower frequencies, rather than cramming the lowest frequencies into a small area on the left side of the graph.

6. Double-click outside the secondary Y-axis—i.e., the one that now has no labels. The Y-axis window will open. In the Graph Data box, select Magnitude (Volts). Close the window. That axis will now have a graph of the signal magnitude measured in volts. Because of the default axis scale, the graph will be near the bottom. Open the Y-axis window again and enter 0.1 (or 100m) in the Top Ref box. Close the window. The graph will look something like this:



The voltage (across an assumed 50 ohms) is now graphed on the right axis (my Primary Axis is the left axis), from zero to 100 mV. The graph of dBm remains as it was.

7. Double-click on or above the date/time stamp at the top of the graph. A window will open allowing you to enter three lines of title information. The date/time stamp is the third line of that title. You can enter something else as the third line, but when you Restart, the third line will be replaced with a new date/time stamp.

8. Open the Sweep Parameters window. In the Graph Appearance box, select Light. Close the window. The graph will change to darker traces on a white background. The new trace colors will override any previously set.

9. Select menu Options→Appearances. A window will open allowing you to select the colors of the background, grid lines and boundary, text and traces. Select what you like, and click Use. The graph will change to use the colors you selected. If you clicked Save As Preset instead of Use, you would have been allowed to save your new color scheme under a name that would appear in the Graph Appearances box in the Sweep Parameters window.

## **Saving Images and Data**

1. **Select Edit→Copy Image.** A copy of the graph (without the buttons on the bottom) is copied to the clipboard. You can open a word processing or image processing program and paste the image into that program. Alternatively, you can select File→Save Image, and the image will be saved as a bitmap to a file of your choice. Some programs cannot read the bitmap files created by Liberty Basic, but the clipboard image is universal.
2. **Select Data→Data Input.** A window will open listing the step number, frequency, and signal magnitude (dBm), plus the actual ADC bit value and frequency correction factor which the MSA used to determine the signal magnitude. For this simulated data, the ADC bit value is always zero. We did not perform a frequency calibration, so the frequency correction is also zero. Using the menus in the data window, you can save the data to a file, or you can select and copy the data for pasting into another program, such as a spreadsheet.

## **Saving Preferences**

1. **When the software is started up, the initial settings come from a file called Prefs.txt.** You can replace that file with the current settings by using menu File→Save Prefs. If you save your preferences as Prefs.txt, they will become effective each time the software starts up. If you save under a different name, they will be activated by using menu File→Load Prefs. If you have changed a lot of settings and want to get back to the startup settings, you can do so by using File→Load Prefs to load Prefs.txt.
2. **If you want to restore the original default preferences file, you can do so by quitting the software, locating Prefs.txt, deleting it and restarting the software.** A new Prefs.txt file will be created. The path to that file is (MSA folder)\MSA\_Info\MSA\_Prefs\Prefs.txt, where (MSA folder) is the folder in which you installed the MSA software.

## **Running Multiple Instances of the Software**

1. **Double-click on the icon for the MSA software to run it. Click Halt.**
2. **Double click on the icon again to open a second instance of the software. Click Halt.**
3. **You will now have two graph windows. You can set the frequency ranges and other settings independently for the two windows. The only restrictions are (1) to avoid confusing the hardware, you must Halt one window before running the other, and (2) anything you do that changes files, such as saving preferences, will affect the same files shared by both windows.**



4. To make the windows more independent, you can copy the entire folder containing your software and files, and run the two separate software copies. In that case, each one will have its own files.

5. This is a useful way to monitor two different frequency bands. Note that the MSA presently does not have automatic switching of filters, so if the two sweeps utilize different resolution bandwidths or video filters, the filters must be manually changed when switching between sweeps.